Claims:

1. A modulation method for multiple-tone signalling for use in a device having a modulator and an analogue front end, the method including the steps of:

processing input data through a plurality of intermediate processing stages and corresponding stages of intermediate data to generate preprocessed data;

inverse Fourier transforming the preprocessed data to obtain a symbol including a number of tones;

buffering the symbol;

modelling the peak amplitude that the symbol would contain after the subsequent processing in the analogue front end and comparing the modelled peak amplitude with a threshold;

if the modelled peak amplitude in the symbol exceeds the threshold, amending predetermined intermediate data such that the input data is still represented by the intermediate data, carrying out the subsequent intermediate processing stages on the regenerated data to regenerate preprocessed data and inverse Fourier transforming the regenerated preprocessed data to obtain a regenerated symbol including a number of tones;

replacing the buffered symbol with the regenerated symbol; and

outputting the buffered symbol through the analogue front end.

2. A method according to claim 1 including, when a regenerated symbol is generated, modelling the peak amplitude the regenerated symbol would contain after processing in the analogue front end and replacing the buffered symbol with the regenerated symbol only if the regenerated symbol has a lower modelled peak amplitude.

3. A method according to claim 1 including, when a regenerated symbol is generated, modelling the peak amplitude the regenerated symbol

would contain after processing in the analogue front end and if the modelled peak amplitude exceeds the threshold, obtaining at least one further regenerated symbol by further amending predetermined intermediate data such that the input data is still represented by the intermediate data, carrying out the subsequent intermediate processing stages on the amended intermediate data to regenerate preprocessed data, inverse Fourier transforming the regenerated preprocessed data to obtain the further regenerated symbol, and replacing the buffered symbol with the further regenerated symbol.

4. A method according to claim 1 including determining whether there is sufficient processing time to regenerate a symbol before regenerating that symbol.

5. A method according to claim 1 wherein the subsequent intermediate preprocessing stages used to regenerate preprocessed data include a scrambling stage.

6. A method according to claim 1 wherein the intermediate data includes a series of data frames including fast bytes and/or sync bytes and the step of amending the predetermined intermediate data includes amending the fast or sync bytes of the data frames.

7. A method according to claim 6 wherein the predetermined intermediate data includes fast bytes or sync bytes having null values with at least one freely selectable bit and the step of amending the predetermined intermediate data includes amending at least one freely selectable bit of the fast or sync bytes having null values.

8. A method according to claim 1 wherein the predetermined intermediate data includes idle cells and the step of amending the predetermined intermediate data includes amending at least one idle cell.

9. A method according to claim 8 wherein the step of amending the at least one idle cell includes selecting, for at least one payload byte in said idle cell, an alternative idle cell payload byte value from a predetermined set of idle cell payload byte values, the number of values in said predetermined set being much less than the total number of possible idle cell payload byte values.

10. A method according to claim 1 wherein the step of amending the predetermined intermediate data includes replacing ATM cells one with the other.

11. A method according to claim 10 wherein the step of amending the predetermined intermediate data includes replacing an idle ATM cell with a new data cell.

12. A method according to claim 10 wherein the step of amending the predetermined intermediate data includes swapping two ATM cells from different data streams.

13. A method according to claim 10 wherein the step of amending the predetermined intermediate data includes replacing a data cell with an idle cell.

14. A modulation method for multiple-tone signalling for transmission by an analogue front end, including the steps of:

processing input data through a plurality of intermediate processing stages and corresponding stages of intermediate data to generate preprocessed data;

transforming the preprocessed data to obtain a symbol including a number of tones;

modelling the peak amplitude the symbol would contain after passing through the analoguefront end, and if the peak amplitude exceeds a predetermined threshold, regenerating the symbol by amending predetermined intermediate data such that the input data is still represented by the intermediate data, and carrying out the subsequent intermediate processing stages and the transforming step on the amended intermediate data.

15. A modulation method for multiple-tone signalling, including the steps of:

processing input data through a plurality of intermediate processing stages and corresponding stages of intermediate data to generate preprocessed data;

transforming the preprocessed data to obtain a symbol including a number of tones;

buffering the symbol;

modelling the peak amplitude the symbol would contain after passing through the analogue front end;

if the modelled peak amplitude in the symbol exceeds a predetermined threshold, amending predetermined intermediate data such that the input data is still represented by the intermediate data, and carrying out the subsequent intermediate processing stages and the transforming step on the amended intermediate data to obtain a regenerated symbol, and

replacing the buffered symbol with the regenerated symbol if a predetermined condition applies; and

outputting the symbol through the analogue front end.

16. A method according to claim 15 including modelling the peak amplitude in the regenerated symbol and wherein the predetermined condition is that the modelled peak amplitude of the regenerated symbol is less than that of the buffered symbol.

17. A computer program product for causing a data processor to carry out the steps of:

processing input data through a plurality of intermediate processing stages and corresponding stages of intermediate data to generate preprocessed data;

inverse Fourier transforming the preprocessed data to obtain a symbol including a number of tones;

buffering the symbol;

modelling the peak amplitude that the symbol would contain after the subsequent processing in the analogue front end and comparing the modelled peak amplitude with a threshold;

if the modelled peak amplitude in the symbol exceeds the threshold, amending predetermined intermediate data such that the input data is still represented by the intermediate data, carrying out the subsequent intermediate processing stages on the regenerated data to regenerate preprocessed data and inverse Fourier transforming the regenerated preprocessed data to obtain a regenerated symbol including a number of tones; and

replacing the buffered symbol with the regenerated symbol.

18. A computer program product according to claim 17 wherein the subsequent intermediate preprocessing stages used to regenerate preprocessed data include a scrambling stage.

19. A transmitter for transmitting multiple tones representing input data, comprising:

a processor for generating preprocessed data from the input data through a series of intermediate processing stages, intermediate data being transmitted between each pair of intermediate processing stages;

an inverse Fourier transform module for obtaining a symbol data stream, each symbol including a number of tones, from the preprocessed data;

a buffer for storing symbol data;

an analogue front end for processing the symbol data from the buffer, the analogue front end including a preprocessing module, a digital-to-analogue converter (DAC) and a line driver for providing an output signal including a plurality of tones;

a modelling unit for modelling the effect of the preprocessing carried out in the analogue front end on the symbols of the symbol data stream and deriving a modelled symbol;

a peak detector for detecting the peak amplitude in the modelled symbol and comparing the peak amplitude with a threshold;

and a regeneration control system for causing the processor, if the peak amplitude in the modelled symbol exceeds the threshold, to carry out the steps of:

amending predetermined intermediate data such that the input data is still represented by the intermediate data;

regenerating preprocessed data by executing the subsequent intermediate processing stages on the regenerated data; and

inverse Fourier transforming the regenerated preprocessed data to obtain a regenerated symbol including a number of tones; and

an analogue front end for outputting the modulated signal.

20. A transmitter according to claim 19 wherein the analogue front end is implemented as a separate chip.

21. A transmitter according to claim 19 wherein the line driver is implemented on a chip and the preprocessing module and digital to analogue converter are implemented on a separate chip.

22. A transmitter according to claim 19 wherein the modelling unit is a further instance of the preprocessing module.

23. A modulator for use in a multi-tone modem including an analogue front end, comprising:

a processor having a plurality of intermediate processing stages for processing input data through stages of intermediate data to generate preprocessed data;

a transform unit for transforming the preprocessed data to obtain a symbol including a number of tones for transmission through the analogue front end;

a modelling unit for modelling the peak amplitude the symbol would contain after passing through the analogue front end,

and a regeneration control unit, for regenerating the symbol, if the peak amplitude exceeds a predetermined threshold, by amending predetermined intermediate data such that the input data is still represented by the intermediate data, and carrying out the subsequent intermediate processing stages and the transforming step on the amended intermediate data.

24. A transmission system comprising:

a transmitter including:

a processor for generating preprocessed data from the input data through a series of intermediate processing stages, intermediate data being transmitted between each pair of intermediate processing stages;

an inverse Fourier transform module for obtaining a symbol data stream, each symbol including a number of tones, from the preprocessed data;

an analogue front end for processing the symbol including a preprocessing module, a digital analogue converter (DAC) and a line driver for providing an output signal including a plurality of tones;

a modelling unit for modelling the effect of the preprocessing carried out in the analogue front end on the symbols of the symbol data stream and deriving a modelled symbol;

a peak detector for detecting the peak amplitude in the modelled symbol and comparing the peak amplitude with a threshold;

and a regeneration control system for causing the processor, if the peak amplitude in the modelled symbol exceeds the threshold, to carry out the steps of:

amending predetermined intermediate data such that the input data is still represented by the intermediate data;

regenerating preprocessed data by executing the subsequent intermediate processing stages on the regenerated data; and

inverse Fourier transforming the regenerated preprocessed data to obtain a regenerated symbol including a number of tones; and

an analogue front end for outputting the modulated signal;

the transmission system further comprising a transmission line; and

a receiver connected to the transmission line for decoding the transmitted data stream.